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E46 Driver Information Systems

Model: E46

Production: From Start of Production

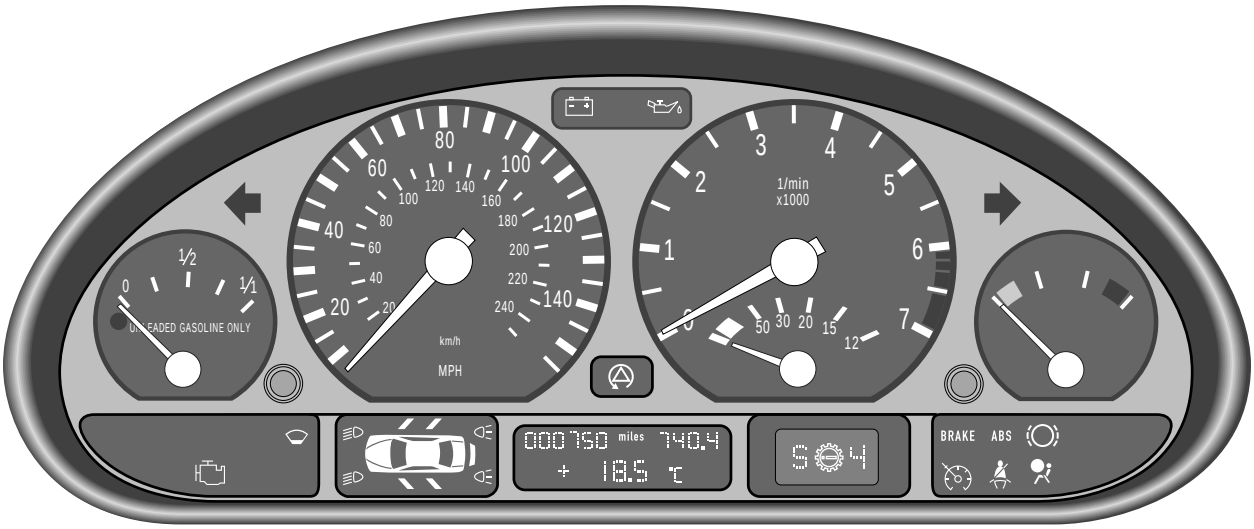
OBJECTIVES

After completion of this module you will be able to:

- Understand the operation of the E46 instrument cluster
- Identify and locate driver information system components
- Diagnose concerns related to the driver information system

E46 Instrument Cluster

The instrument cluster is part of the overall driver information system. The design of the E46 instrument cluster is similar to the “low” version cluster introduced on the E39.



The cluster on the E46 still uses the five familiar analog gauges which are the fuel level, speedometer, tachometer, coolant temperature and the fuel economy gauge.

There are also three LCD blocks which display:

- **Check Control Pictogram** - this area displays information regarding lamp failures, door and trunk status as well as fluid levels (i.e. coolant and washer fluid)
- **Odometer Display** - this display shows total mileage and trip odometer information. The Board Computer (BC) information is also displayed here. There are 5 pieces of information which can de displayed here by scrolling with the turn signal stalk switch. The new service interval indicator is also displayed here (SIA IV).
- **Transmission Display** - the transmission range and program indicator is shown here. Any transmission related faults are indicated to the driver by a gear symbol.

In addition to the LCD display blocks, there are various indicator lamps some of which include the oil pressure warning, battery charge indicator, MIL etc.

The E46 makes extensive use of bus network for communication between control other vehicle systems. The bus network also helps streamline communication and reduce the overall wiring requirement.

Other features of the E46 cluster include:

- Stepper motor drives for the analog gauges
- New design Service Interval Indicator (SIA IV)
- Automatic transmission range/program display

The instrument cluster is a sealed unit and contains no serviceable components, other than the back lighting illumination bulbs.

Bus Communication

The E46 cluster is part of a vehicle bus network which includes the following bus systems:

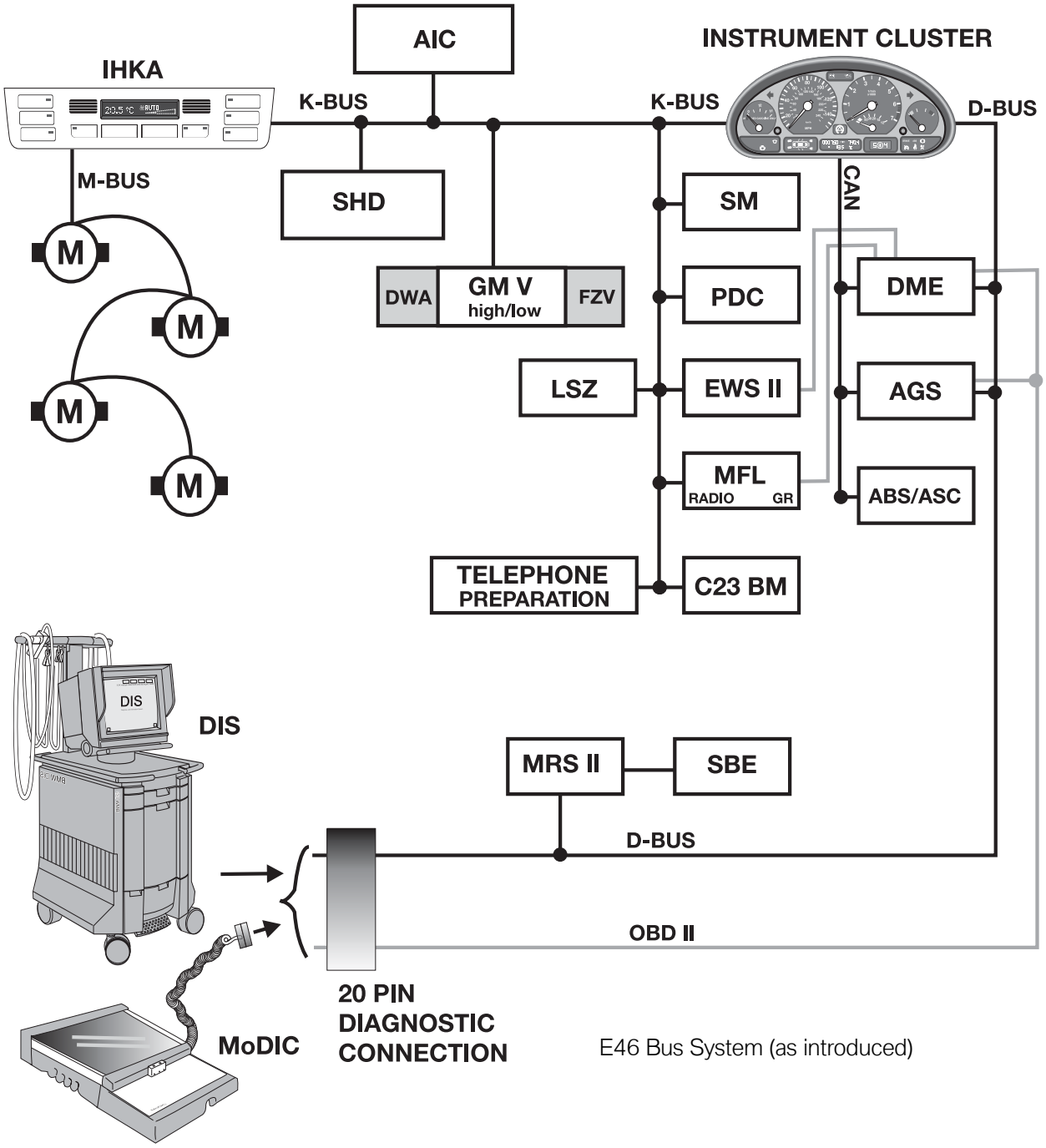
- **Controller Area Network** - The CAN bus supplies the cluster with information to operate the tachometer and fuel economy gauge. The “TD” (engine speed) and the “ti” (injector on time) signals are now sent to the cluster as part of the CAN-Bus signals rather than independent dedicated signals as before. The transmission range, program and fault indicator signals are also now a part of CAN-Bus information as well. This further reduces the wiring requirement and increases reliability.
- **Body Bus** - The K-bus provides the cluster with a connection to other vehicle systems such as the LSZ, IHKA and GM. Signals are shared between these systems which allow for a reduction in sensors and switches.
- **Diagnosis Bus** - The D-bus allows diagnostic communication between the vehicle and the diagnostic equipment. The cluster provides a “gateway” to connect the D-bus and other bus networks.

Gateway Function

The cluster provides a connection between bus systems. This allows different bus networks to transfer information between them. The cluster “translates” this information and distributes it to the required network. For example, the D-bus does not connect directly to all modules on the E46. Any modules on the K-bus are diagnosed via the pathway created by the cluster. The path is as follows - D-bus > cluster > K-bus > component.

Signals are also shared via the gateway as well as commands. An example of this would be the cruise control system. The MFL control module, which control cruise control switches, sends a command to the DME system. The DME systems is responsible for engine speed control. The command for “accelerate” for example, is sent to the DME via the gateway (cluster) to the CAN-Bus.

E46 Bus Overview



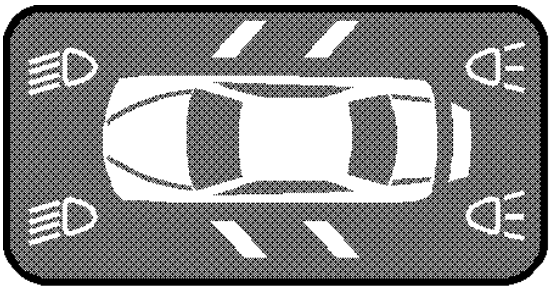
E46 Bus System (as introduced)

Cluster Displays

Check Control LCD Matrix

The pictogram check control display carries over from the E39 for failure display warnings of various lights, doors/trunk open and low fluid indications.

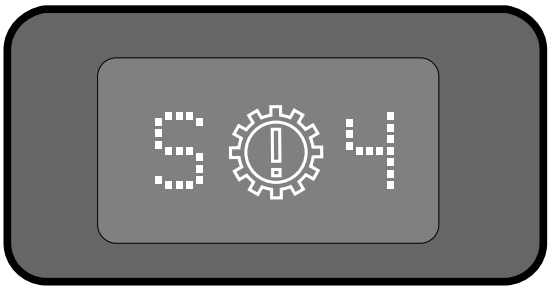
Inputs for warning lamp indication are processed by the cluster electronics and the appropriate LED is illuminated.



Transmission Matrix Display

The right LCD matrix is used to display the driving range and program on vehicles equipped with an automatic transmission.

The transmission fault display is now also integrated into the display matrix. The gear with the explanation point will illuminate when the electronic control of the transmission detects a fault.



Odometer/BC Display

The odometer/BC display shows the total mileage as well as the trip odometer reading. The SIA IV also displays for 5 seconds when the key is switched on to display service interval information.

The BC also displays 5 basic pieces of information which can be scrolled with the turn signal stalk switch.

Dynamic Digital Inputs

Distance Signal

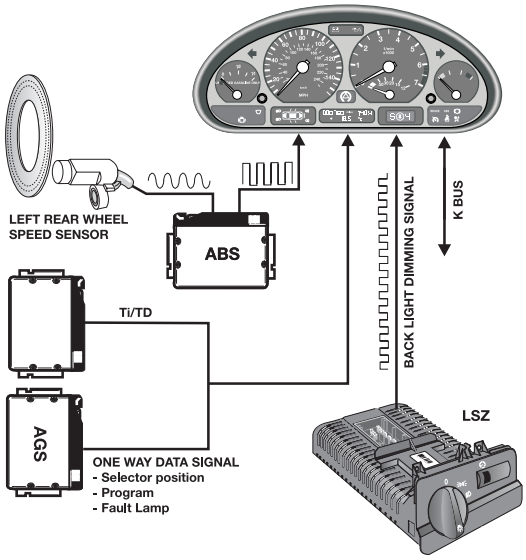
This input is supplied to the cluster by the ABS/ASC/DSC control module as a square wave signal. Pulses from the left rear wheel speed sensor are processed by the ABS module to produce this signal. The cluster electronics process the input for the cluster display and pass the signal along, on the K-Bus, as speed signal "A" for other control modules requiring the vehicle speed signal.

CAN-Bus Signals

The "Ti" , engine temperature and "TD" signals are produced by the DME control module and sent to the cluster. The cluster also passes the TD signal out over the K-Bus.

Transmission Data

The EGS (AGS) control module provides the range selector position, driving program and fault lamp activation signals to the cluster over the CAN line.



Oil Temperature

This input is a pulse width modulated signal from the Electronic Oil Level Sensor. As oil level decreases the pulse width of the signal increases. If the signal shows an oil level that is too low over a period of time, the instrument cluster will illuminate the Oil Warning indicator LED in yellow.

Dimmer Signal

This is a pulse-width modulated signal from the LSZ. It is used to control the intensity of the back lighting of the instruments and the LCDs when the lights are switched ON. This signal is also output over the "K"-Bus.

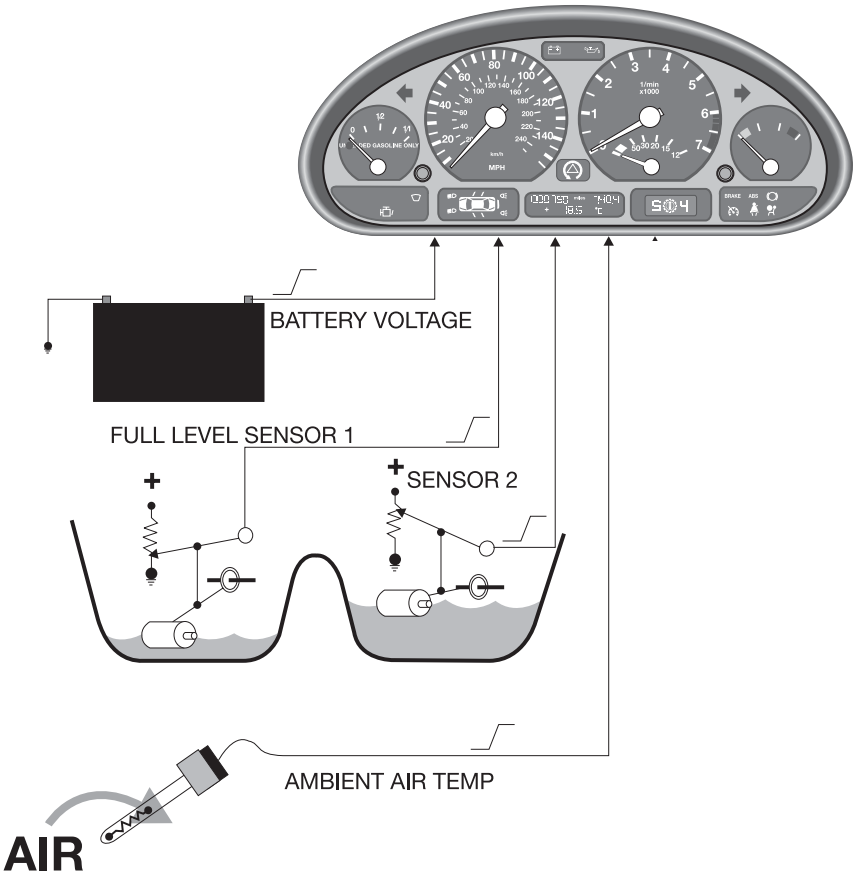
K-Bus Signalling

The Cluster receives signals for the Check Control Pictogram over the K-Bus.

Analog Input Signals

Battery Voltage
Battery voltage is monitored by the cluster and a fault is stored if the voltage exceeds 16 volts.

Fuel Tank Level
Two lever action sensors are wired in parallel to the cluster. The two varying voltage signals are processed by the cluster for fuel gauge and low fuel warning display.



Outside Temperature Sensor
A Negative Temperature Coefficient (NTC) sensor is used to measure the ambient temperature. The signal is processed by the cluster and passed out over the K-Bus to modules requiring this input for processing.

Digital Input Signals

Digital inputs refer to those inputs which are represented by a ground or B+ signal. The status of these signals is represented by a change in voltage either on or off (1 or 0).

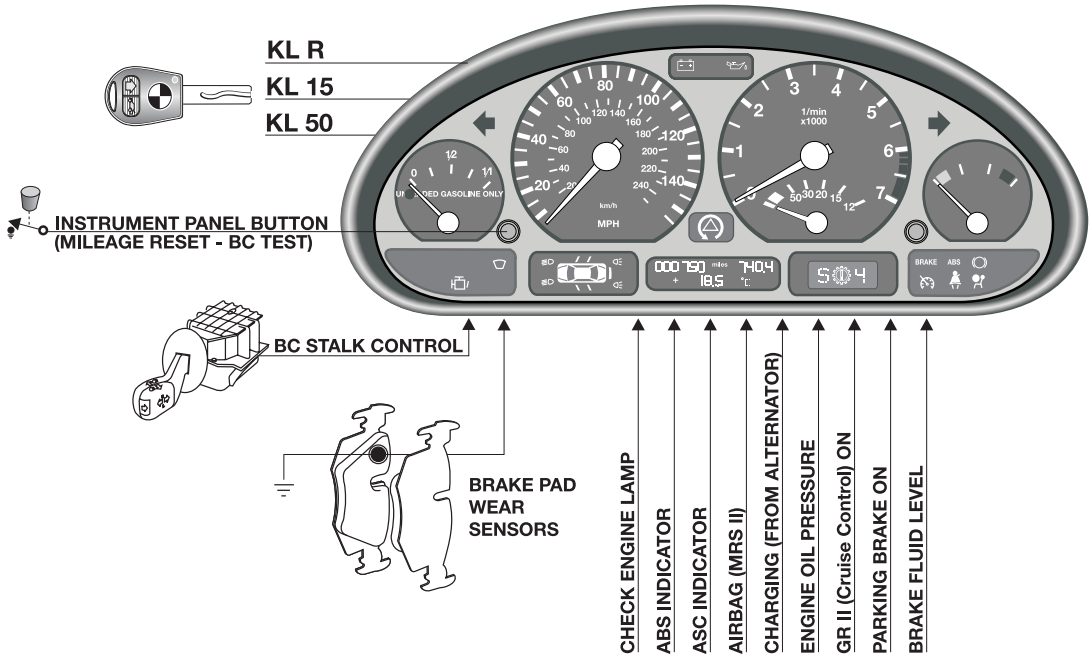
The normal ignition switch terminals (KL R, KL 15 & KL 50) are input to the cluster. Various functions are dependent on ignition switch position.

Steering Column Stalk Switch

As with previous systems the turn signal stalk is used to call up BC functions. The stalk switch (LSS) is a ground input to the cluster.

Brake Pad Wear Sensors

The pad sensor inputs are used to illuminate the brake pad warning indicator as in the past. The brake pad circuit is monitored for an open or interruption of the ground when the sensor is worn through. The input is dampened to prevent a blinking light when the sensor is not completely open.



Instrument Panel Button

The reset button is used to reset the trip - odometer as in the past. It will also display the mileage, if pressed with the key switched OFF. This button is also used for BC/cluster test functions.

Inputs for Warning Lamps

Various switches are used to signal the cluster for warning and indicator lamp illumination including fluid levels, control unit fault and status indicators. Examples of these include the MIL lamp from the ECM (DME), the RPS indicator from the CVM, the seat belt status and Airbag Warning Lamp (AWL) from the MRS control module.

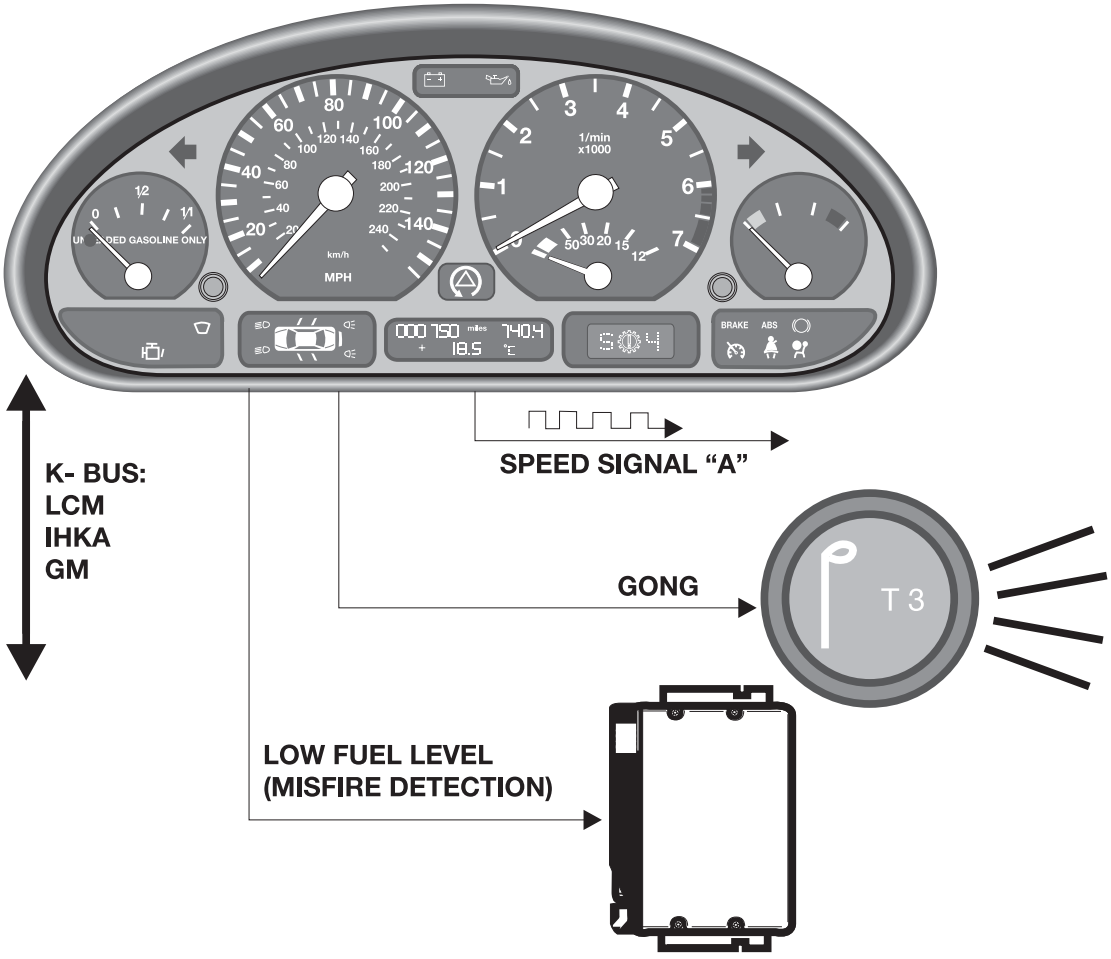
Output Signals

Speed Signal “A”
The vehicle speed signal is available as an output for control modules that require precise vehicle speed information. Speed signal “A” is also sent as an output over the K-Bus.

K-Bus Interface
The K-Bus is used to transfer data between the cluster and other modules on the link. The diagnostic interface also passes over the K-Bus for troubleshooting with the BMW diagnostic equipment.

Low Fuel
Based on the processing for the low fuel indicator lamp, this output is also sent to the DME (ECM) control module. The signal is stored along with a mis-fire detection fault for troubleshooting purposes.

Gong Output
The T3 tone is used for check control warnings.



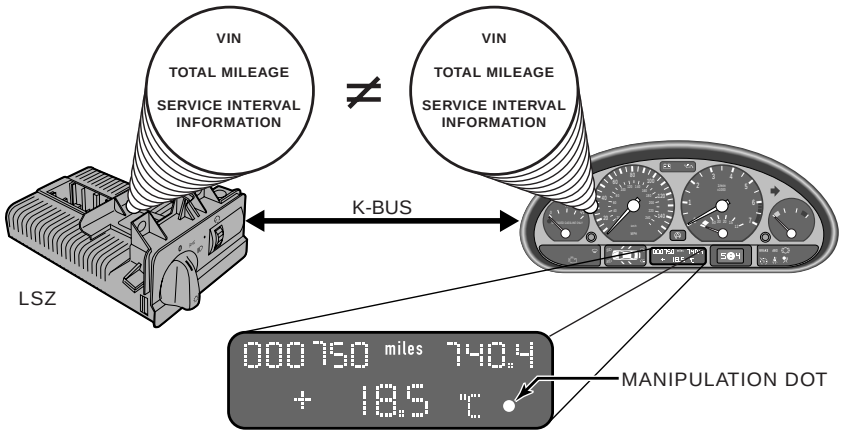
Redundant Data Storage

Specific information is stored redundantly in the instrument cluster and in the Light Switch Module. The data stored redundantly includes:

- VIN
- Total Mileage
- Service Interval data

The redundant storage of this information allows for the replacement of a module without the loss of the total mileage accumulated or the loss of the SI data.

The data is compared each time KL 15 is switched on. If the data does not match, the manipulation dot in the mileage display block will be illuminated.

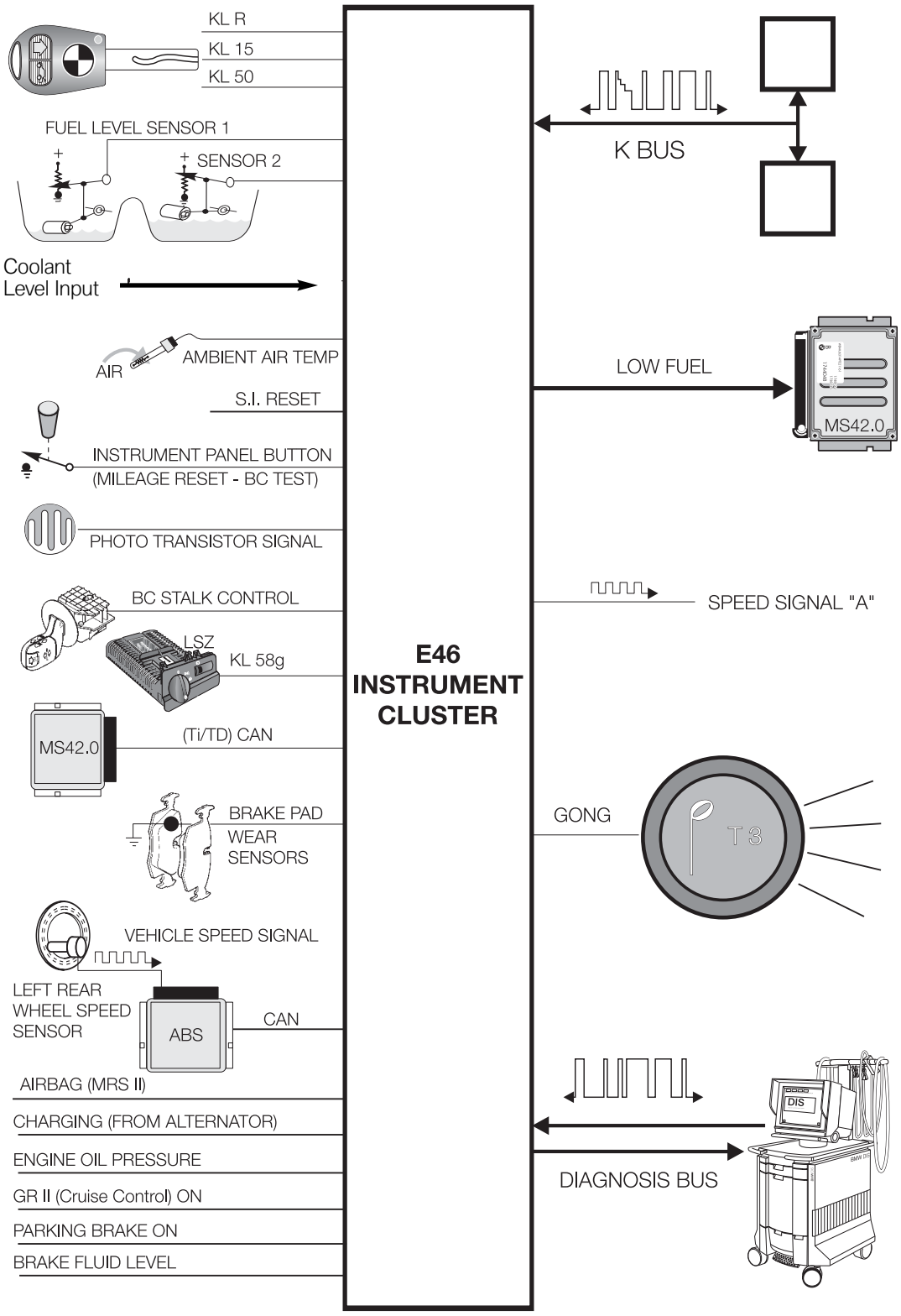


The following points must be noted with regards to the redundant storage of this data.

1. If the vehicle ID number is not the same in both modules, the manipulation dot is illuminated. All functions of both modules continue to operate.
2. Data will only be transferred from the LSZ to the cluster if the ID numbers match and the cluster mileage is zero.
3. The VIN is entered in the cluster through coding and will only be accepted when the cluster mileage is zero.
4. The stored mileage in the LSZ can only be overwritten by a higher mileage.
5. If the two mileage values stored vary by more than 120, and the VINs are the same, the cluster will continue to accumulate mileage and a fault will be stored in the cluster for data transfer.
6. If the K-Bus link fails, the cluster will continue to store mileage and set a fault for the Bus link.

New components should only be installed for replacement purposes and not for use as test components for diagnosis as miles will accumulate if the vehicle is driven for road testing purposes.

E46 Cluster Overview



Service Interval Indicator (SIA IV)

Beginning with the E46, the new SIA IV service interval indicator system is now used. The new system now longer uses the colored LED's as used in the past, but rather a numeric display of mileage remaining to the next service.

With this system, the actual mileage remaining until the next service will be displayed when the ignition is turned on. The service mileage will be displayed in the odometer display for approximately 5 seconds.

The text "Oil Service" or "Inspection" will also illuminate to show which service is due. A minus (-) symbol before the mileage display indicates that a service is past due.

The calculation process for determining the service interval is similar to SIA III. Like the SIA III system, the SIA IV system calculates service intervals based on fuel used.

A reference value of fuel is stored in the instrument cluster during the coding process, this value is in gallons and is model dependent. As the vehicle is driven, the instrument cluster monitors the injector on time ("ti") signal and deducts the amount of fuel used against the reference value.

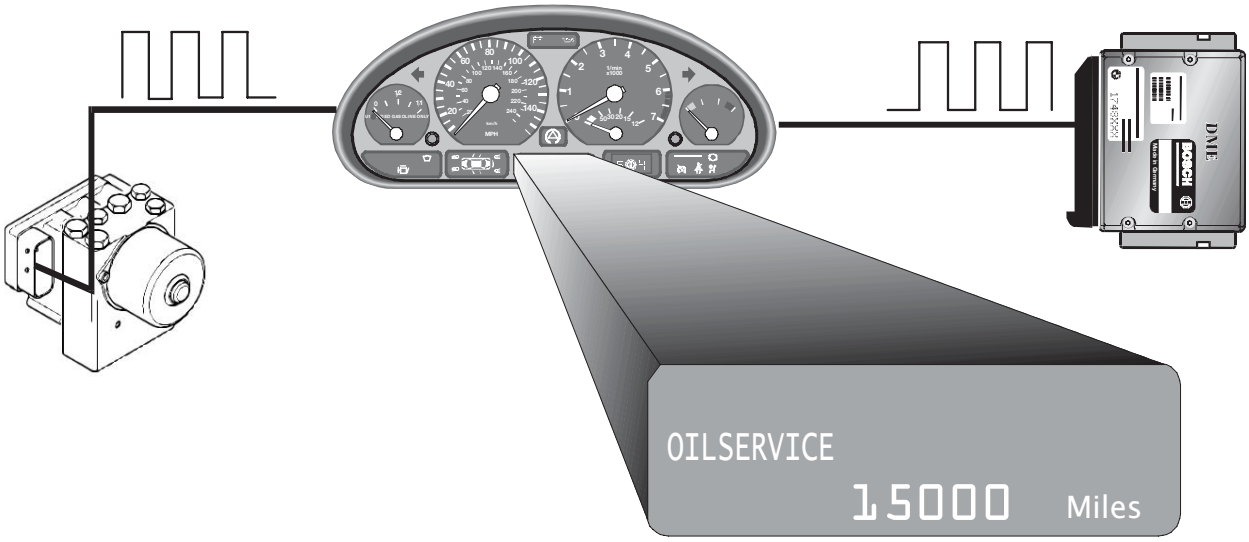
In other words, the injector on time is an indicator of how the vehicle is driven.
For example, a large number of short trips would consume more fuel and therefore the average injector on time would be greater. This increased fuel consumption would reduce the service interval mileage because the average injector on-time would be higher and would deduct gallons (theoretical) from the stored value (Coded Inspection Limit) at a faster rate.

The "Coded Inspection Limit" value for each vehicle can be found in a Group62 Service Bulletin.

System Components

The SIA IV system consists of the instrument cluster, the engine control module and the stability control system (ASC/DSC). The instrument cluster contains all of processing electronics and the SIA display in the odometer area.

The stability control system supplies the road speed signal and the engine control module supplies the injector on time ("ti") signal via the CAN-Bus.



Service Interval Reset

When a vehicle comes in for an oil service or inspection (I or II), the service indicator must be reset. This is important to assure consistent service intervals. Depending upon the production date of the vehicle, there are a few methods to reset the service intervals.

On vehicles with a diagnosis socket in the engine compartment, the service interval indicator is reset with the aid of the SIA reset tool (62 1 110). On vehicles where this diagnosis socket is no longer installed in the engine compartment (2001 models an up), the service interval indicator (SIA) is reset according to a defined procedure with the left-hand button in the instrument cluster (trip odometer reset button).

Although the 20-pin underhood diagnostic connector was omitted in 2001 vehicles, the "Reset Mode" in the instrument cluster was possible from 9/99.

In addition to the reset mode in the cluster, the SIA could be reset using the diagnostic equipment (DISplus/GT-1).

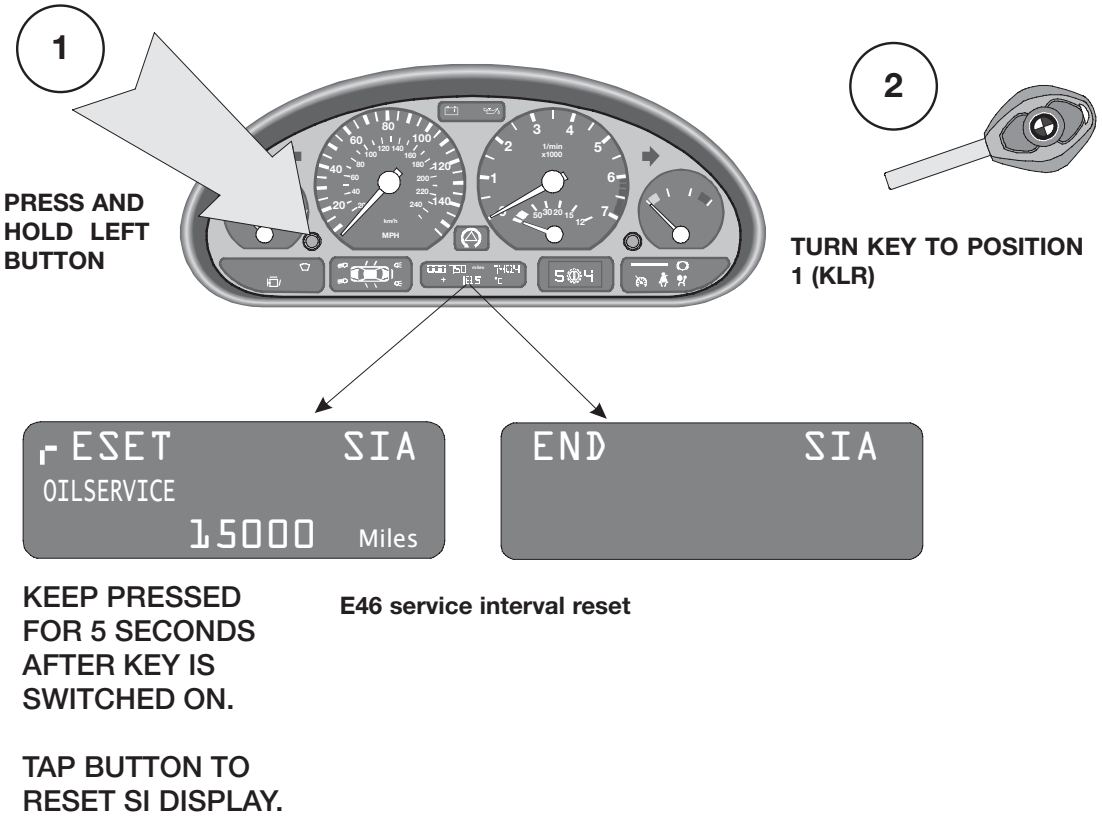
SIA Reset Procedure using Reset Mode (from 9/99)

The reset procedure is as follows:

- Ignition key must be “off”
- Press and hold the trip odometer button in the instrument cluster, and turn the ignition to KLR.
- Keep the button pressed for approximately 5 seconds until one of the following words appears in the display: “OIL SERVICE” or INSPECTION with the additional text - RESET.
- Release the button and press and hold it again until the “reset” begins to flash.
- While the display is flashing, press the left button briefly to reset the service interval. After the display has shown the new interval, the following will appear: “END SIA”

Note: The system can only be reset again after 10 liters (2.5 gal) of fuel has been consumed.

The data for the service interval indicator (SIA) are also stored in the light switching center (LSZ). After replacing the instrument cluster, completing encoding and allocation based on the vehicle identification number, the SIA data are transferred to the instrument cluster.



E46 service interval reset

Reset using Diagnosis Program

The DISplus or GT-1 can be used to reset the Service Interval Indicator. The procedure is as follows:

- Connect the Diagnosis head to the diagnostic connector of the vehicle.
- Identify the vehicle and perform the Short Test.
- Select Function Selection and then Service Functions.
- Highlight Reset Service Interval Indicator (Test module S6211-00001)
- Select with tester.
- Follow the directions from the help information in the test module (upper right corner).
- Select which service is to be reset and press the continue key.
- An acknowledgement is displayed on the screen that the reset has been carried out.

Instrument Cluster Replacement

If the instrument cluster (Kombi) is replaced the SI data can be retrieved from the LSZ on

E46 vehicles and from the LCM III on the E52. Coding procedures are the same as SIA II.

Diagnosis

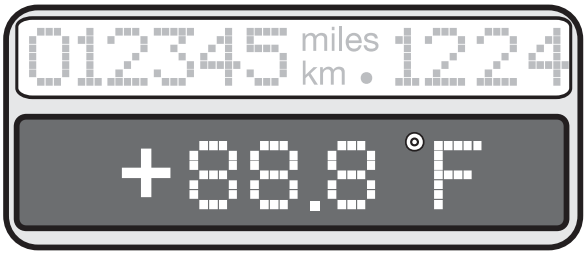
Diagnosis of the SIA System is carried out using the Diagnosis program of the DISplus or Gt-1.

On Board Computer

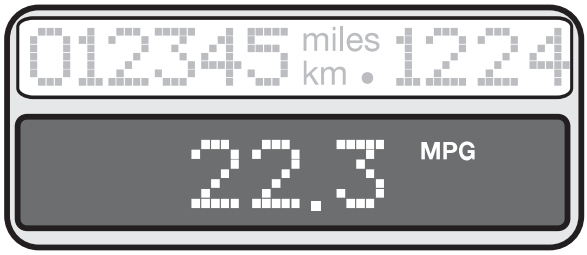
The On Board computer of the E46 contains the following functions:

- Time
- Outside temperature
- Average fuel consumption
- Driving range on remaining fuel
- Average speed

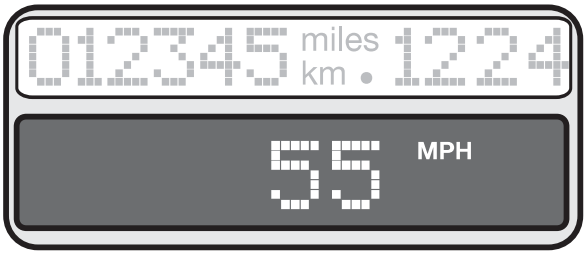
• OUTSIDE TEMPERATURE



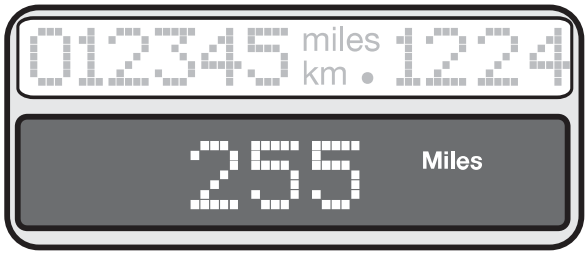
• FUEL CONSUMPTION



• AVERAGE SPEED



• ESTIMATED DRIVING RANGE ON REMAINING FUEL



The current time is always displayed when KL R is switched on. Any other BC display value can be called up by pressing the turn signal lever.

To set the clock “turn” the odometer reset button to the left or right to set the desired time.

To reset any other programmable displays - hold the turn signal lever in for > 2 seconds.

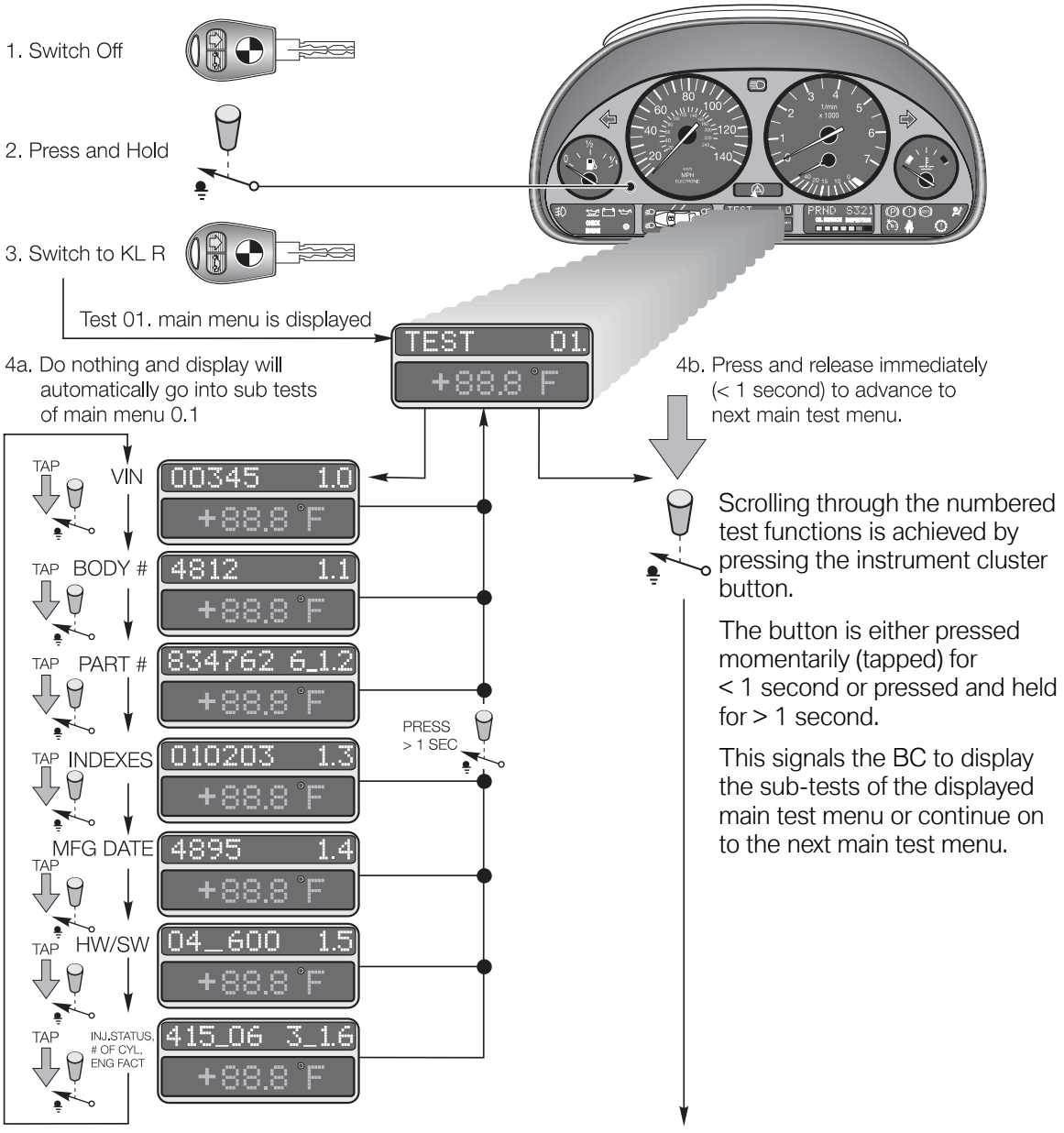
A freeze warning is incorporated into the BC. If the temperature drops below 37 degrees, the gong will sound and the temperature display will flash.

The displays of the Board computer can be changed over from Fahrenheit to Celsius by pressing the instrument cluster button and switching the ignition key on. IHKA display will also change over. The average fuel consumption and average speed displays are reset by pressing and holding the turn signal lever for > 2 seconds. The BC then starts to calculate new average values.

Instrument Cluster Test Functions

In addition to the fault memory and diagnostic link, the base instrument cluster contains a series of test functions that can be accessed to check various functions and values. The test functions are displayed in the mileage LCD block. There are a total of 21 test functions. The test functions are similar to those of previous Board computers and contain similar tests.

- Tests 1 & 2 are always unlocked.
- Tests 3 -21 are only accessible after unlocking the test function.
  Test 19 is the unlock function for accessing the displays.



Instrument Cluster Test Functions (1-6)		
TEST 01. Vehicle specific data including:		
Values (simulated)	**Subtests:**	
12345	1.0	VIN
4812	1.1	Body Number
834762	6_1.2	Part number of cluster
010203	1.3	Coding/Diagnosis/Bus index
3495	1.4	Manufacturing date (Calender week/year
04_600	1.5	Hardware/software # of cluster (HW:04, SW:6.00)
415_06	3_1.6	Injection status, number of cylinders, engine factor
TEST 02. - Cluster System Test - activates the gauge drivers, indicators and LED's to confirm function.		
TEST 03. - SI Data		
Values (simulated)	**Subtests:**	
1500	3.0	liters
0	3.1	Period inspection days (not applicable for US market)
TEST 04. - Momentary Consumption.		
Values (simulated)	**Subtests:**	
0267	4.0	26.7 liters/1000km
0073	4.1	7.3 liters per hour
TEST 05. - Distance Gone Consumption (Range)		
Values (simulated)	**Subtests:**	
0195	5.0	19.5 liter/100km
226	5.1	momentary distance to go (226km)
TEST 06. - Fuel level sensor input in liters		
Values (simulated)	**Subtests:**	
237415	6.0	Fuel level averaged - LH sensor input = 23.7 liters RH sensor = 41.5 liters
0652	6.1	Total tank level averaged = 65.2 liters
0667	1_6.2	Indicate value and tank phase 1 = both sensors OK 2 = one sensor fault 3 = implausible input

Instrument Cluster Test Functions (7-19)

TEST 07. Temperature and Speed:		
Values (simulated)	**Subtests:**	
032	7.0	Coolant temp input = 32 C
245	7.1	Outside temperature input = 24.5 C
5283	7.2	Engine speed 5,283 RPM
058	7.3	Vehicle speed 58km/H
TEST 08. - Input values in hexadecimal form		
Values (simulated)	**Subtests:**	
XXX	8.0-8.3	Hex code, instrument cluster inputs (for engineering use)
TEST 09. - Battery Voltage		
Values (simulated)	**Subtests:**	
125	9.0	12.5 volts
TEST 10. - Country Coding		
Values (simulated)	**Subtests:**	
02	10.0	US 02
TEST 11. - Cluster Code		
Values (simulated)	**Subtests:**	
000003	11.0	Cluster code
TEST 12. - Not used		
TEST 13. - Gong Test		
Values (simulated)	**Subtests:**	
Gong	13.0	Activate gong by pressing button (gong response is delayed)
TEST 14. - Fault memory - (not for diagnosis)		
TEST 15 to 18 - Not used		
TEST 19 - Lock/Unlock		
Values (simulated)	**Subtests:**	
L-ON		Display changes from “L-ON“ to “L-OFF” every second. To unlock test functions, press the cluster button immediately when it changes to “L-OFF”. Tests are automatically locked when exiting test functions.
L-OFF	19.0	

Instrument Cluster Test Functions (20-21)		
TEST 20. Not Used		
TEST 21. - Input values in hexadecimal form		
Values (simulated)	**Subtests:**	
Reset	21.0	Reset software

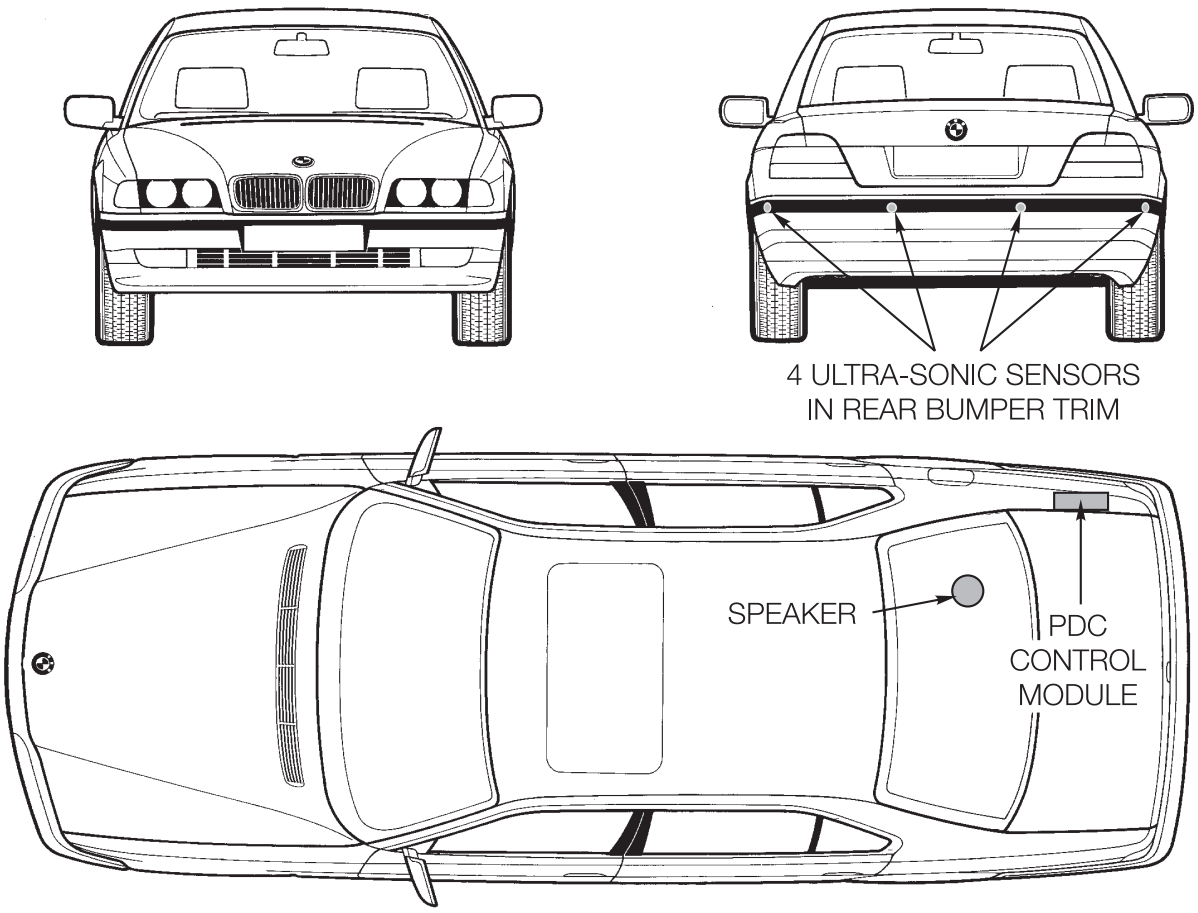
Park Distance Control

Park Distance Control is a safety/convenience system that is an option on the E46. The system is carried over from the E39 and features the ultra-sonic sensors on the rear bumper only.

The sensors detect the close proximity to other objects when maneuvering the vehicle in tight spaces (such as parallel parking or parking in narrow garages spaces).

The driver is warned, through an audible tone (beeping), when the vehicle comes close to another object. As the distance to the object decreases, the beeping frequency increases until a steady tone is produced. As the distance to the object increases, the steady tone will return to a beep and stop when the vehicle moves away from the object.

The PDC is automatically switched ON when the ignition is switched on, however it does not become active until the vehicle is shifted into reverse.



Components

The PDC consists of the following components:

PDC Control Module

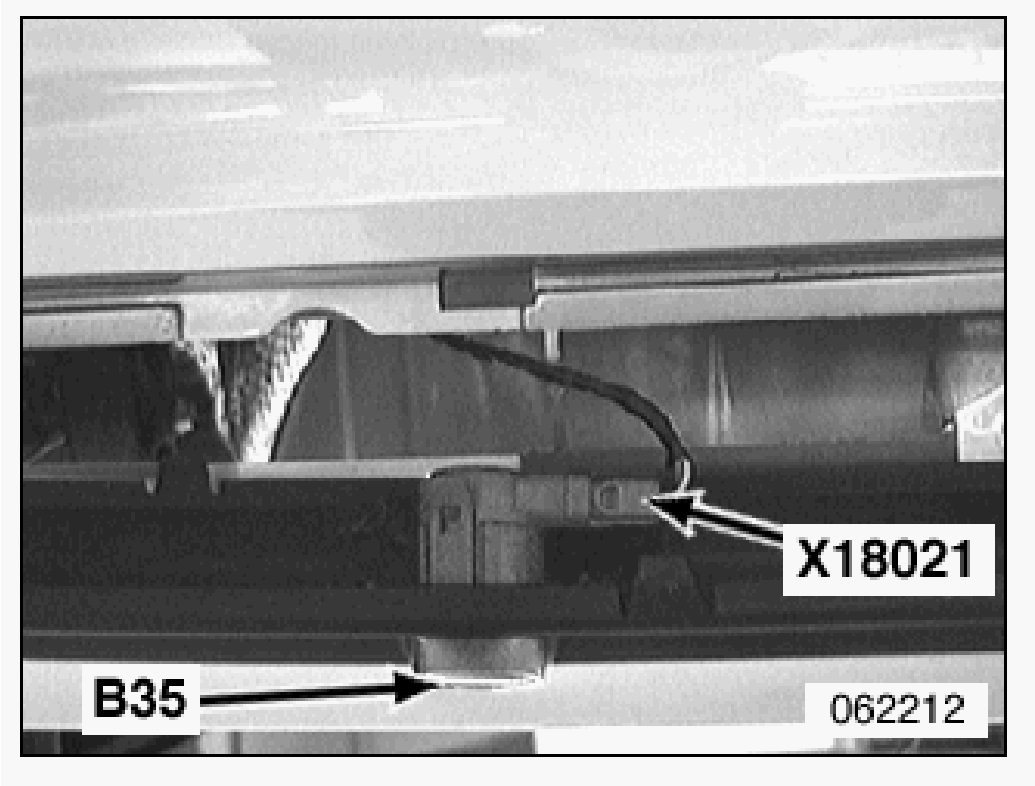
The PDC control module activates the ultrasonic sensors mounted in the rear bumper cover. After activation, the module monitors the signals coming back through the sensors. Through this signal, the control module is able to determine the distance to any object close to the bumpers of the vehicle. As the vehicle comes close to an object, the control module will activate the acoustic warning through the right rear audio system speaker.

The PDC control module is mounted in the trunk on the right side above the battery.

Ultrasonic Sensors

Mounted in the rear bumper. The sensors are small transmitter/receiver modules that are specifically designed for automotive use. The sensors are limited to the following angles of monitoring:

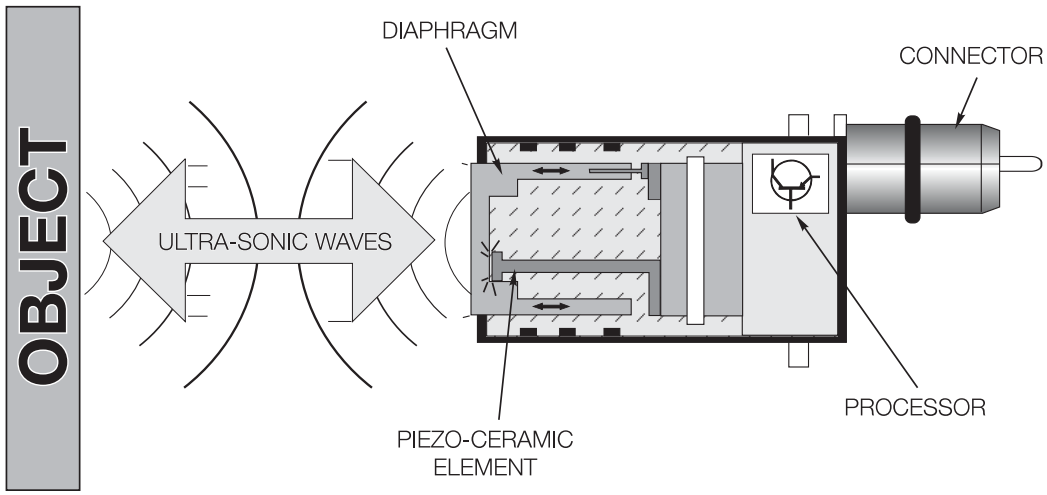
- 90° on the horizontal plane
- 60° on the vertical plane



Transmitting Mode
The control module sends a 40 Khz signal to the sensor and each sensor is then activated in a specific sequence (firing order). The ceramic element of the sensor vibrates and produces an ultrasonic sound wave that is sent out from the bumper.

Receiving Mode
If the sound wave contacts an object, the wave is bounced back to the sensor. The returning wave causes the ceramic element to vibrate creating an electrical signal as feedback to the control module.

The control module determines the distance to the object by the time difference between the sent signal and the received ultrasonic wave signals.



System Operation

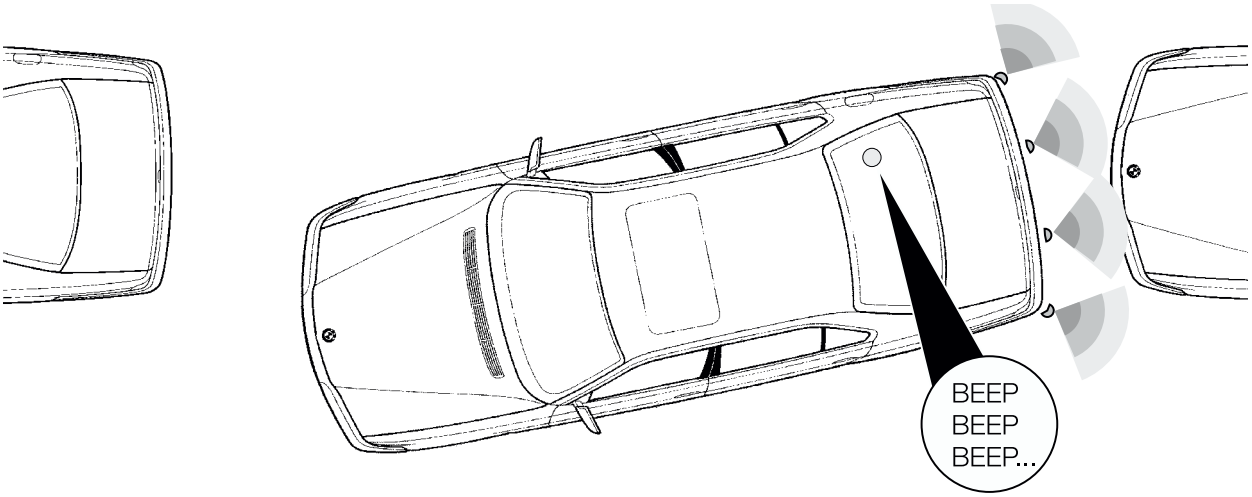
When KL 15 is switched ON, the PDC system is switched "ON", in the standby mode. The system performs a self-check of the ultrasonic sensors and control electronics.

When the vehicle is shifted into reverse, the system is activated and the sensors are activated in the predetermined order.

If an object is detected within the operating range of one the sensors, a signal is sent to the PDC control module and the acoustic warning is generated. At the same time the control module checks the signals from the adjacent sensors to help determine the actual distance to the object.

As the distance to the object decreases, to approximately 1 ½ feet, the output acoustic frequency increases until a steady tone is generated.

As the distance to the object increases the frequency will decrease until the object is out of the monitoring range of the sensor.



Workshop Exercise - Diagnosis

Using an instructor designated vehicle, diagnose the concern indicated by the instructor. Complete this worksheet using the proper "Complaint, Cause and Correction" format.

Vehicle: _____ Chassis #: _____ Production date: _____

Complaint:

Cause:

Correction:

Workshop Exercise - Diagnosis

Using an instructor designated vehicle, diagnose the concern indicated by the instructor. Complete this worksheet using the proper "Complaint, Cause and Correction" format.

Vehicle: _____ Chassis #: _____ Production date: _____

Complaint:

Cause:

Correction:

Classroom Exercise - Review Question

1. Why is it important that the instrument cluster and LSZ should NOT be replaced at the same time?

2. What bus systems are connected to the E46 instrument cluster?

3. What is the purpose of the “pictogram” display?

4. What is the “low fuel level” output signal used for?

5. Explain SIAIV processing:

Classroom Exercise - Review Questions

6. List the OBC functions on the E46 instrument cluster:

7. How does the IHKA module receive outside temperature information?

8. What information does the E46 instrument cluster receive from the CAN-Bus?

9. Describe the “gateway”function on the E46 cluster:

10. When does the E46 PDC system become active?